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MEMORANDUM FOR DR. F. C. CRAIGHEAD:

Results of a Preliminary Study of the Retardation of the Annual Rings of Yellow Pine and Lodgepole Pine Defoliated by Coloradia pandora, Blake; on the Klamath Indian Reservation, Oregon.

Palo Alto, California.
February 5, 1925.

J. E. Patterson,
Assistant Entomologist.

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GENERAL REMARKS

At the suggestion of Dr. F. C. Craighead the writer, and assistant Mr. P. D. Sergent, conducted preliminary examinations and made annual ring measurments of some defoliated trees on the Klamath Indian Reservation to ascertain the effect of repeated annual feeding of Coloradia pandora on the growth of these trees.

The results of these preliminary studies are given in this paper.

The history of the present Cploradia pandora epidemic in the pine stands of this region dates from 1918 when adult moths first appeared on the headwaters of the Williamson River. Reports of this large flight of moths were received at the Ashland Station in the fall of 1920. They were sent in by F. M. Wilkes, Forest Topographer, who was conducting a topographic survey of the Reservation. Mr. Wilkes stated that previous to 1918 no moths had been noticed on any areas of this reservation. The writer visited the infested areas in the early spring of 1921 and found the insect in two local areas only. One of these areas was located 5 miles north of Calimus Butte, and the other on Wocus Bay some miles farther north. Outside of these two areas no evidence of the presence of the insect could be found. These reports and examinations definitely determine that the present epidemic started in 1918

and the first heavy defoliation occurred in the spring of 1919.

The stages of development during the life history of Coloradia pandora permit heavy feeding of the caterpillars during alternate years only. Its life history has been worked out and is the subject of a separate paper now in preparation. However, to throw additional light on the results of defoliation by the caterpillars, a brief resume of its life history is given as follows:

Adults fly and deposit eggs in July of even years, as in 1918, 1920, 1922 and 1924. Eggs hatch in September and the young caterpillars immediately start feeding. They attain a length of 5 mm by November when winter conditions prevent further activity until the following spring. In April the caterpillars resume feeding which is continued until June when pupation occurs. During the prepupal period the caterpillars attain their maximum size and consume an average of 2½ mature pine needles each every 24 hours. Pupae form in the surface soil in June and remain there one year or until the following June and July when the adults emerge.

Thus there are two periods when the caterpillars are actively feeding on the foliage, one in the fall during the years of flight, when they are small, and during the period when the seasonal growth of the trees is almost over, and the other during the spring periods of the succeeding years when the caterpillars are full grown, requiring the maximum amount of food during periods when the trees should be making the greatest annual growth and when defoliations result in the most damage.

As a result of the above habits maximum defoliations of the trees occur during the spring of alternate years from flight and just prior

to pupation. These periods occurred in 1919, 1921 and 1923.

Knowing the period of the year of the first heavy feeding of the present epidemic and the pecularities of the insect's life history and feeding habits the problem was to correlate these with a curve of radial annual increment corresponding with these event periods. An attempt to show this correlation is presented in the attached graphs.

PROCEDURE

Six separate plots in the infested region were selected to supply cross sections showing the annual growth of defoliated trees. These plots were selected in separate areas to permit the securing of data on trees growing under different environmental conditions and also data on the effects of defoliations of different periods. Both yellow pine and lodgepole pine, the only trees attacked in this region by the insect, were analysed.

A cross section was taken from the top, middle and base of each tree selected for examination. These section were numbered in the field so that they could later be identified as to plot, etc., when the measurments of the radii of annual growth were made. These measurments were made in the laboratory in October 1924. A binocular microscope equipped with a micrometer disc was used in measuring the radius of the annual rings. The measurments in all cases were taken to the nearest one-tenth millemeter.

The results of these growth analyses are given for each series or plot in the accompanying tables. The graphs show the curves of the average annual radial increment and are based on the tables.

DESCRIPTION OF SAMPLE PLOTS

Yellow Pine:

Series A - B & E:

Location: Klamath Indian Reservation, Oregon. Twp. 33 SR 10 E, Will. Mer. 5 miles north of Calimus Butte:
Elevation: 5,400 ft.
Slope: North, northeast and east.
Exposure: Same.
Soil: Decomposed volcanic pumice, dry and loose.
Ground cover: Very little. Some small brush in scattered patches. Heavy carpet of dead pine needles on surface of ground.
Stand: Pure yellow pine type. Medium aged. Trees small in diameter for age. Many younger trees overtopped and suppressed.
Defoliation: This area was one of the two first attacked at the beginning of the present epidemic. The moths first appeared here in 1918 and the first heavy defoliation occurred in the spring of 1919. The defoliations have been continuous since that time with periods of heavy feeding during April, May and June of alternate years since 1919.
Trees examined:
Series A - 3 trees.
Series B - 5 trees.
Series E - 12 trees.

Cross sections of these trees were taken in September 1924 after the current fall wood had formed.

Series C:

Location: Klamath Indian Reservation, Oregon. Twp 34 SR 9 E, Will. Mer. 4 miles southwest of Calimus Butte.
Elevation: 4,600 ft.
Slope: South.
Exposure: South-east.
Soil: Decomposed volcanic pumice, loose and dry.
Ground cover: Scattered small brush and yellow pine reproduction.
Stand: Pure yellow pine type of medium age.
Defoliation: First heavy feeding of present epidemic occurred in spring of 1919. Defoliations have occurred every year since.
Trees examined:
Series C - 3 trees.

Cross sections of these trees were taken in Sept 1924.

Series F:

Location: Klamath Indian Reservation, Oregon. Twp 34, SR 12 E. Will. Mer. In the Black Hills.
Elevation: 5,600 ft.
Slope: North.
Exposure: North-east.
Soil: Loose, dry volcanic pumice.
Ground Cover: Same as former plots.
Stand: Mixed yellow pine and white fir. 80% pine. Medium aged with very little reproduction.
Defoliation: The moths invaded this area in 1920 and the first period of heavy feeding occurred in the spring of 1921. Area has been defoliated every year since then.
Trees examined:

Series F - 7 trees.

Cross sections of these trees were taken in Sept 1924.

Lodgepole Pine:

Series D:

Location: Location and other statistics same as given for series A, B and E.
Trees examined:

Series D - 3 trees.

Cross sections taken in Sept 1924.

COLORADIA PANDORA, Blake:

Ring Measurments Defoliated Trees:

Yellow pine:

Calimus Butte Area:

Series A: Top Cross Section:

Section:	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924
1	14	12	9	9	7	7	5	5	5	2
2	12	12	9	8	8	7	6	4	5	3
3 3	17	14	12	10	9	8	7	3	4	3
Total	43	38	30	27	24	22	18	12	14	8
Average	14	13	10	9	8	7	6	4	4.6	2.6

Series A: Base Cross Section:

1	3	5	5	6	6	5	4	3	2	1
2	5	8	6	4	3	5	6	4	3	2
3	3	4	3	3	4	3	3	1	1	1
Total	11	17	14	13	13	13	13	8	6	4
Average	3.6	5.6	4.6	4.3	4.3	4.3	4.3	2.6	2	1.3

10 = 1 mm.

H. W. Webb, Sta. J, New York, N. Y.

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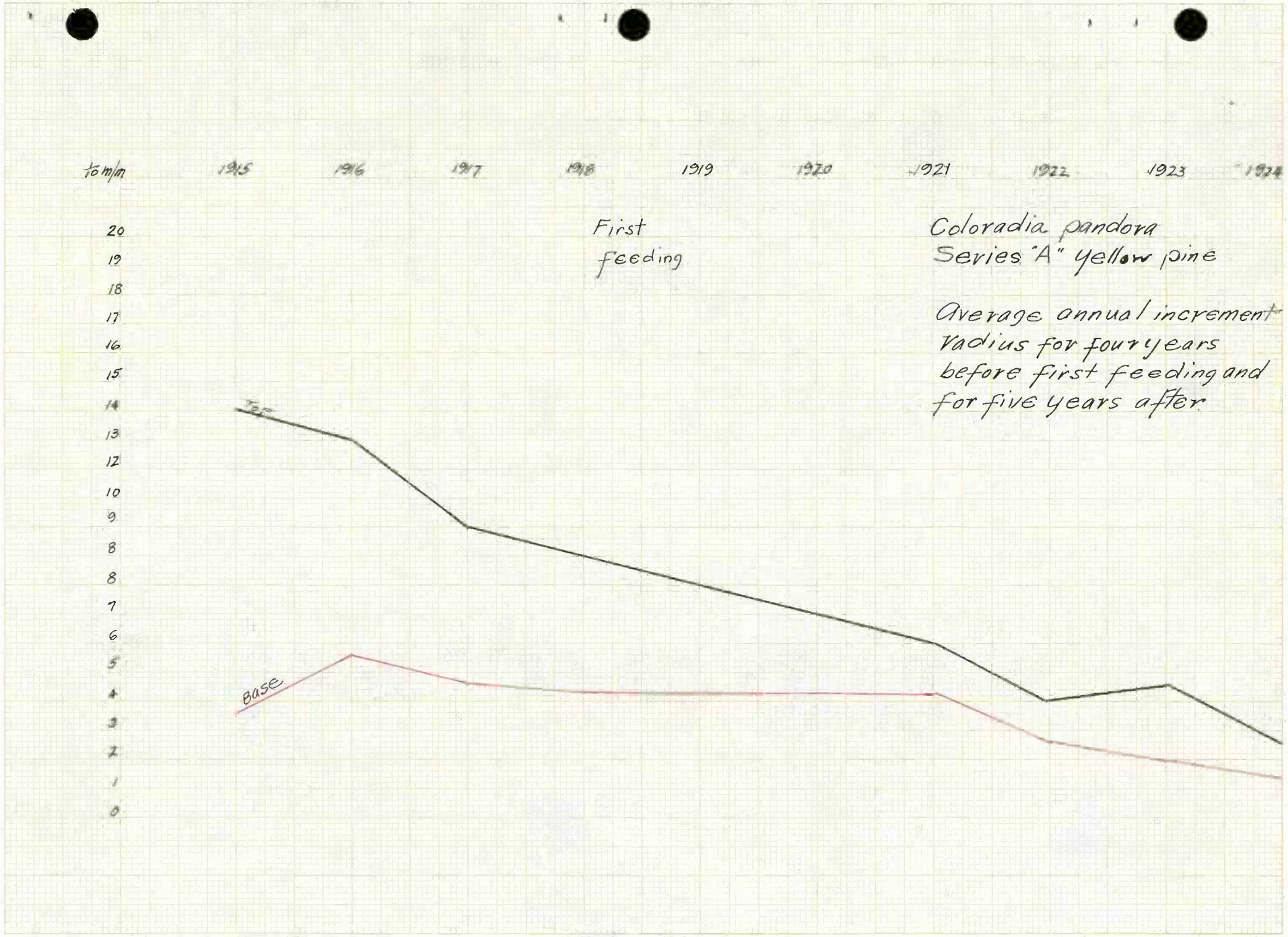

COLORADIA PANDORA, Blake:

Ring Measurments Defoliated Trees:

Yellow pine:

Calimus Butte Area:

Series B: Top Cross Section:

Section:	1916	1917	1918	1919	1920	1921	1922	1923	1924
1 (FCC)	20	15	10	6	3	6	7	10	15
2 (JEP)	40	37	23	12	8	2	3	2	3
Total	60	52	33	18	11	8	10	22	18
Avergae	30	26	16	9	5	4	5	11	9

Series B: Base Cross Section:

1 (FCC)	12	11	17	6	8	5	3	4	2
2 (JEP)	13	10	13	13	16	10	6	4	3
Total	25	21	30	19	24	15	9	8	5
Average	12	10	15	10	12	8	5	4	3

Series B: Old Epidemic:

(FCC)	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883
Top	18	12	7	3	5	5	5	7	9	6	10
Base	12	9	7	6	5	1	3	3	5	4	6

10 - 1 m/m.

COLORADIA PANDORA, Blake:

Ring Measurments Defoliated Trees:

Yellow pine:

Calimus Butte Area:

Series C: Top Cross Section:

Section:	1916	1917	1918	1919	1920	1921	1922	1923	1924
1	30	24	24	20	18	16	12	22	15
2	20	22	22	16	12	10	4	3	3
3	5	5	4	6	4	3	2	15	15
4	9	9	10	11	8	12	9	7	2
5	10	10	10	6	6	8	8	10	5
Total	74	70	70	59	48	49	35	57	40
Avergae	15	14	14	12	10	10	7	11	8

Series C: Base Cross Section:

1	21	20	15	9	14	8	7	3	3
2	22	15	30	20	17	19	6	22	15
3	10	10	20	10	20	10	9	7	5
4	4	4	4	5	3	5	6	5	3
5	5	5	5	2	3	2	4	4	1
Total	62	54	84	46	57	44	32	41	27
Average	12	11	13	9	11	9	6	8	5

10 - 1 m/m.

COLORADIA PANDORA, Blake:

Ring Measurments Defoliated Trees:

Lodgepole pine:

Calimus Butte Area:

Series D: Top Cross Sections:

Section:	1916	1917	1918	1919	1920	1921	1922	1923	1924
1	19	18	15	13	11	9	5	4	4
2	28	20	16	15	15	12	7	7	6
3	25	20	18	15	14	13	9	12	7
Total	72	58	49	43	40	44	21	23	17
Average	27	19	16	14	13	15	7	8	6

Series D: Base Cross Section:

1	10	10	11	10	9	7	1	2	3
2	5	4	6	5	4	4	2	2	2
3	10	8	9	10	8	5	2	2	2
Total	25	22	25	25	21	16	5	6	7
Average	8	7	8	8	7	5	2	2	2.6

10 - 1 m/m.

H. W. Webb, Sta. J, New York, N. Y.

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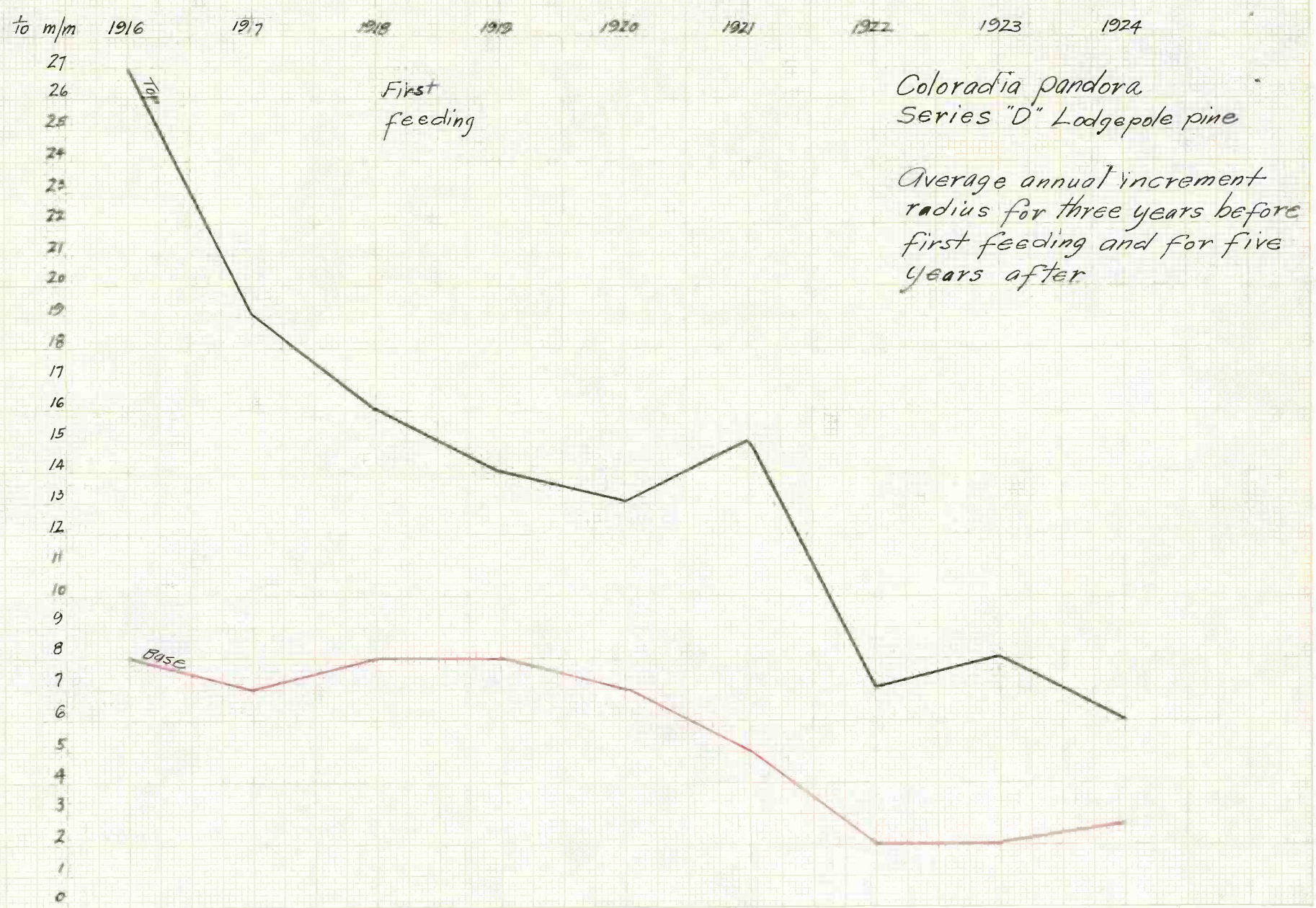


Coloradia pandora
Series "D" Lodgepole pine

Average annual increment radius for three years before first feeding and for five years after

COLORADIA PANDORA, Blake:

Ring Measurments Defoliated Trees:

Yellow pine:

Calimus Butte Area:

Series E: Top Cross Sections:

Section:	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924
1	8	10	7	3	2	2	4	4	4	4
2	3	3	3	3	2	2	5	2	2	2
3	6	6	6	6	3	3	3	3	2	2
4	4	4	4	3	3	3	3	3	2	2
5	20	20	20	20	20	15	15	10	8	6
6	2	2	2	2	2	3	3	3	2	2
7	3	3	3	3	2	2	2	2	2	2
8	5	4	4	4	3	2	2	2	2	2
9	5	5	4	.5	3	3	3	2	1	2
10	6	6	7	4	2	3	3	2	1	1
11	7	5	7	8	3	2	2	1	2	2
12	8	8	6	6	4	4	5	3	2	1
Total	77	76	73	67	49	44	50	37	30	28
Average	6.5	6.5	6	5.5	4	3.7	4	3	2.5	2.3

Series E: Base Sections:

1	10	10	2	4	3	3	4	4	3	2
2	6	6	7	6	4	5	4	5	3	1
3	7	8	8	6	2	4	3	5	2	1
4	6	8	8	6	4	3	3	4	3	1
5	8	7	7	8	5	3	4	4	2	2
6	9	6	6	9	5	4	6	3	3	1
7	7	5	9	8	6	5	6	2	2	2
8	7	7	7	4	9	2	5	4	4	2
9	6	9	6	9	8	6	1	4	1	2
10	5	10	7	4	7	2	2	3	2	1
11	9	8	7	5	4	4	2	4	3	2
12	7	8	3	4	4	6	4	5	2	2
Total	87	92	77	73	61	47	44	47	30	19
Average	7	8	6.4	6	5	4	3.8	4	2.5	1.6

10 - 1 m/m.

COLORADIA PANDORA, Blake:

Ring Measurments Defoliated Trees:

Yellow pine:

Black Hills Area:

Series F: Top Cross Sections:

Section:	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924
1	5	5	4	4	3	3	2	2	1	1
2	7	5	3	2	2	2	2	1	1	1
3	8	8	7	6	6	4	3	2	2	2
4	5	5	6	5	5	4	2	2	1	1
5	4	4	5	4	3	4	2	3	2	3
6	5	4	6	5	5	3	4	2	1	1
7	4	4	5	4	3	2	3	1	1	1
Total	38	35	36	30	27	22	18	13	9	10
Average	5.5	5	5	4.3	4	3	2.4	2	1.3	1.4

Series F: Base Sections:

1	3	3	2	2	2	2	3	1	.5	.5
2	3	2	2	2	2	2	2	1	1	1
3	6	7	7	6	4	4	3	2	2	3
4	5	5	5	6	5	4	3	3	4	4
5	4	4	3	3	2	2	2	3	2	1
6	8	8	8	8	6	6	6	3	2	2
7	6	6	6	7	6	4	4	4	2	1
Total	35	35	33	34	27	24	23	17	13.5	12.5
Avergae	5	5	4.7	5	4	3.4	3.3	2.4	2	1.8

10 - 1 m/m.

COLORADIA PANDORA, Blake:

Ring Measurments Defoliated Trees:

Summary of Series in yellow pine:

Calimus Butte Area:

Tops Cross Sections:

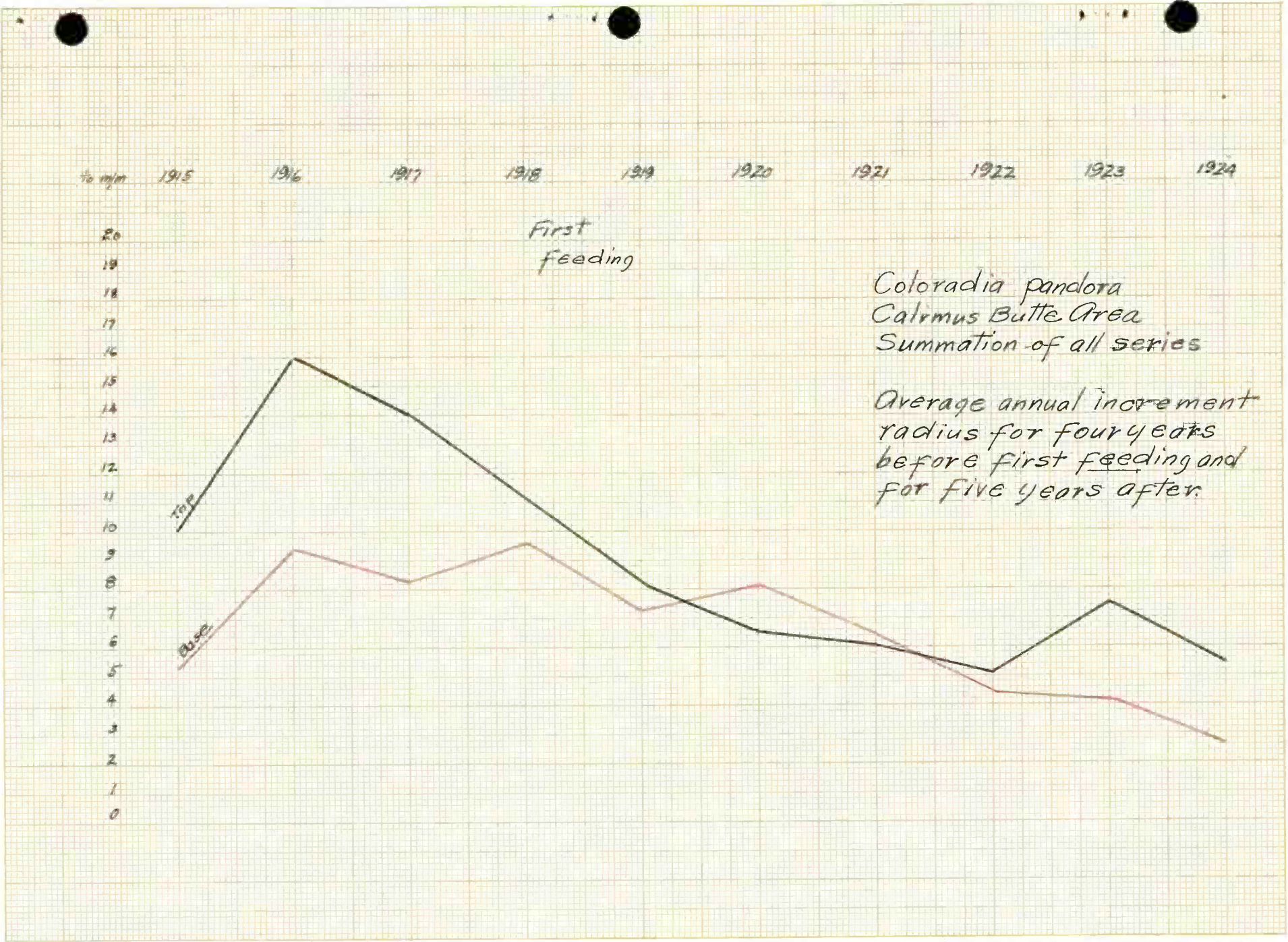
Series:	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924
A	14	13	10	9	8	7	6	4	4.6	2.6
B		30	26	16	9	5	4	5	11	9
C		15	14	14	12	10	10	7	11	8
E	6.5	6.5	6	5.5	4	4	4	3	2.5	2.3
Total	20.5	64.5	56	44.5	33	25.7	24	19	29.1	21.9
Average	10.2	16.1	14	11.1	8.2	6.4	6	5	7.3	5.5

Base Cross Sections:

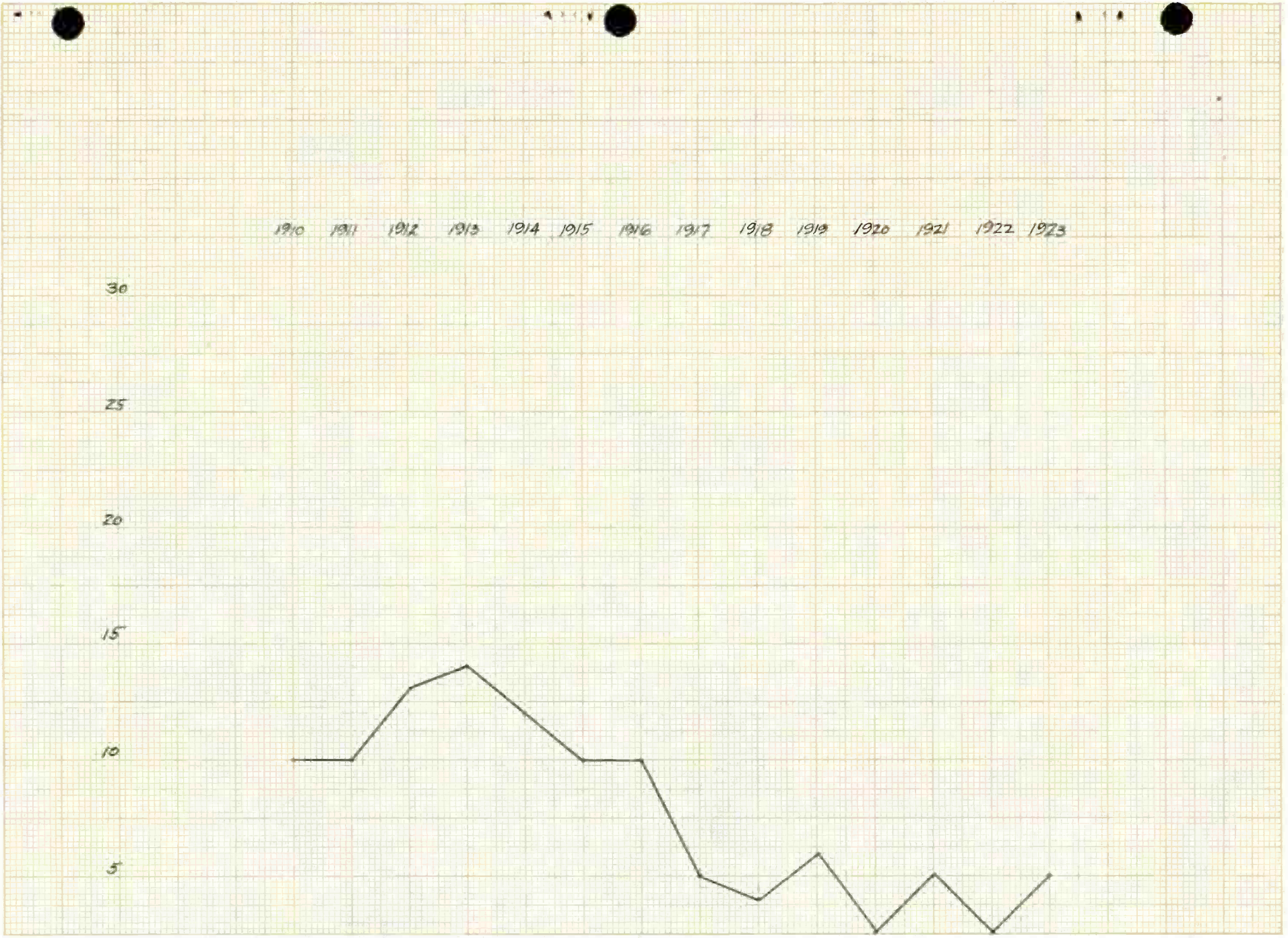
A	3.6	5.6	4.6	4.3	4.3	4.3	4.3	2.6	2	1.3
B		12	10	15	10	12	8	5	4	3
C		12	11	13	9	11	9	6	8	5
E	7	8	6.4	6	5	4	3.8	4	2.5	1.6
Total	10.6	37.6	33	38.3	28.3	31.3	25.1	17.6	16.5	10.9
Average	5.3	9.4	8.2	9.6	7.1	8	6.3	4.4	4.1	2.7

H. W. Webb, Sta. J, New York, N. Y.

—Negative 2.



Graph showing annual radial increment of yellow pine trees at Chiloquin, Oregon. This site is 20 miles west of the plots where the data on defoliated trees were secured. Soil and environmental conditions are the same but the trees have not been defoliated. This curve should be compared with those from the defoliated areas shown in the preceding graphs. Data for this graph based on basal cores taken by O. H. Haugs.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